PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-042211

(43)Date of publication of application : 16.02.2001

(51)Int.Cl. G02B 13/16
G02B 13/04
G02B 13/18
G02F 1/13

(21)Application number : 11-213373

(22)Date of filing : 28.07.1999

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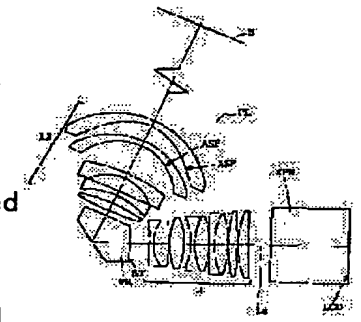
(54) PROJECTION LENS AND PROJECTION DEVICE USING THE LENS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a projection lens and a projection device using the lens capable of projecting the original picture of a projected picture displayed on a liquid crystal display element to the surface of a screen with high optical performance.

SOLUTION: Picture information on plural color light beams based on plural display element is synthesized through a color synthesizing means and enlarged and projected by a projection lens PL to the surface of the screen S in this projection device. The lens PL is provided with a 1st lens group L1 having positive refractive power, a diaphragm, a means for folding an optical path, and a 2nd lens group L2 having negative refractive power in the above mentioned order from the display element side.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] It is the projection device characterized by having the means which bends the 1st lens group which has refractive power are the projection device which compounds the image information of two or more colored light based on two or more display devices through a color composition means, and carries out expansion projection on a screen side with a projector lens, and more nearly forward than this display device side to order in this projector lens, a diaphragm, and an optical path, and the 2nd lens group which has negative refractive power.
[Claim 2] Said projector lens is the projection device of claim 1 characterized by carrying out incidence to said color composition means, without receiving the optical operation as for which is an abbreviation tele cent rucksack and the flux of light from this display device has refractive power in said display device side.
[Claim 3] The means which bends said optical path is claim 1 or the projection device of 2 characterized by being prism.
[Claim 4] The means which bends said optical path is claim 1 or the projection device of 2 characterized by being a mirror.
[Claim 5] Claims 1, 2, and 3 characterized by satisfying $2.0<|f2/f|<4.0$ when the focal distance of f2 and the whole system is set to f for the focal distance of said 2nd lens group, or 4 projection devices.
[Claim 6] The projection device of any 1 term of claims 1-5 characterized by satisfying $0.50<lref/ltt<0.75$ when distance to the lens plane peak point location by the side of a screen is most set to ltt for the distance to the reflector of the means which bends said optical path from said display device from 1ref and a liquid crystal display component.
[Claim 7] Said drawing is the projection device of any 1 term of claims 1-6 characterized by satisfying $0.75<o1/f1<1.0$ when it has been arranged near the optical-path bending means and the focal distance of o1 and this 1st lens group is set to f1 for the distance from this diaphragm to the principal plane location by the side of the screen about said 1st lens group.
[Claim 8] Said 2nd lens group is the projection device of any 1 term of claims 1-7 characterized by the negative lens and both the lens side of the shape of a meniscus of at least two sheets which turned the convex in order [side / said / screen] having the convex positive lens.
[Claim 9] The projection device of any 1 term of claims 1-8 characterized by including at least one aspheric lens in said 2nd lens group.
[Claim 10] The aspheric lens contained in said 2nd lens group is the projection device of claim 9 characterized by being a product made from plastics.
[Claim 11] The projection device of any 1 term of claims 1-10 characterized by including at least one aspheric lens in said 1st lens group.
[Claim 12] The aspheric lens contained in said 1st lens group is the projection device of claim 11 characterized by being a product made from plastics.
[Claim 13] Said 1st lens group is the projection device of any 1 term of claims 1-12 characterized by including the lamination lens of a positive lens and a negative lens with which a positive lens is arranged at said display device side at least 2 sets.

[Claim 14] The projection device of any 1 term of claims 1–13 characterized by making a focal distance adjustable by making adjustable lens group spacing in said 1st lens group.
[Claim 15] The projection device of any 1 term of claims 1–14 characterized by carrying out Floating adjustment by making adjustable lens spacing in said 2nd lens group.
[Claim 16] In the projector lens which projects a projection image on a predetermined side, this projection image side of this projector lens is a tele cent rucksack. The means which bends the 1st lens group of forward refractive power, a diaphragm, and an optical path in order from this projection image side, It has the 2nd lens group of negative refractive power. The focal distance of the i–th lens group And fi, The projector lens characterized by satisfying 2.0<f2/f<4.00.75<o1/f1<1.0 when distance from f and this diaphragm to the principal plane location by the side of this predetermined side of the 1st lens group is set to o1 for the focal distance of the whole system.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the projection device using the suitable projector lens and suitable it especially for miniaturization of a rear projection set using the projector lens which has the good tele cent rucksack engine performance to the color composition prism by the side of a liquid crystal display component as a projector lens which carries out expansion projection on a screen, and has low distortion and the outstanding color property further in the finite distance which had the image displayed on display devices, such as a liquid crystal display component, fixed, concerning the projection device which used a projector lens and it.
[0002]
[Description of the Prior Art] Before, using display devices, such as two or more liquid crystal display components, the image of each colored light based on the display device is compounded, and the display (projection device) which carries out color projection is well used for the screen side.
[0003] While highly minute–ization of a projection image progresses in recent years, the demand of a miniaturization of the whole equipment becomes strong and a thing small [a projector lens] and highly efficient is desired.
[0004] Usually, in order to reconcile the high brightness and high definition of a projection image, the white light from the light source is divided into the colored light of three colors of R, G, and B, it has the display device which generates each colored light, the colored light image based on two or more of these display devices is compounded, and many projection devices projected on a screen side are used through one projector lens.
[0005] As a projector lens, the formation of an extensive field angle is comparatively possible for the so–called projection lens (projector lens) of the negative reed–type which the lens group of negative refractive power precedes with a screen side (plane–of–incidence side), and it is easy to secure a long back focus as compared with a focal distance, and it has the features that it is mainly suitable for the

lens for projections of 3 plate methods. However, on the other hand, there are also problems, like the overall length of optical system becomes large.

[0006] Two kinds, a CRT method and a rear projection method, exist in television of current and a consumer specification. Among these, the troublesome technical problem that equipment is enlarged, that a CRT method becomes heavy, etc. is held. On the other hand, to the needs of commercial scenes, such as a thin shape and lightweight-izing, although rear projection television is advantageous, there are needs (I want to design thinly) to carry out skillful ****** of the tooth space of the formation of an extensive field angle of a projection lens and the depth direction (the thickness direction), as movement toward miniaturization of the further equipment.

[0007] According to JP,9-218379,A, miniaturization in the depth direction of a rear projection set is attained by establishing the optical-path bending means which consists of prism into the projection system using a retro focus type wide angle lens.

[0008]

[Problem(s) to be Solved by the Invention] When compounding the image (display image) of three colored light based on red, green, and three liquid crystal display components for blue by the color composition system and carrying out expansion projection on a screen, in order to attain the miniaturization of the whole equipment, maintaining an optical property good, it is necessary as a projector lens to satisfy the following conditions.

[0009] (**-1) In order to eliminate the effect of include-angle dependence of the die clo IKKU film for the color composition when compounding the luminous-intensity-distribution property of a liquid crystal display component or two or more colored light, and in order to aim at good matching with an illumination system and to fully secure the illuminance in the circumference of a screen, it is the so-called telecentric optical system which has an apparent pupil location (liquid crystal display component side pupil) in the method of infinite distance to color composition prism.

[0010] (**-2) Since a retro focus type projector lens has distortion of a spool mold by the screen side, in order are not conspicuous and to carry out it, in the case of rear projection television, especially distortion aberration should press many down for less than 0.5% of absolute values.

[0011] By said JP,9-218739,A, the condenser lens is put in immediately after the liquid crystal display component to the above-mentioned requirement. this sake — the color composition prism inside the projection system — receiving — a liquid crystal display component — a tele cent — if rucksack lighting is performed, the pupil location of the appearance to the projection system, especially color composition prism will be transposed to finite distance, and is hard to be called configuration advantageous to the irregular color in the color composition cross section on a screen.

[0012] Moreover, since said condenser lens was needed according to each color panel (three sheets) number of sheets, there was an inclination used as a complicated configuration.

[0013] In order to secure the tooth space which arranges an optical-path bending means in the projection device which has, on the other hand, arranged an optical-path bending means to make the big include angle of 90 degrees or more reflect the flux of light into optical system, it is necessary to set up appropriately the refractive power of each lens group of optical system. It becomes difficult to obtain good optical-character ability, having a predetermined projection field angle, if refractive-power arrangement is not appropriate.

[0014] It aims at offer of the projection device using the projector lens and it which can project this image, maintaining good optical-character ability on a screen, attaining the miniaturization of the whole equipment by setting up the configuration of this projector lens appropriately, in case this invention compounds the image of two or more colored light based on two or more display devices with a color composition means and projects it on a screen side with a projector lens.

[0015]

[Means for Solving the Problem] The projection device of invention of claim 1 is a projection device which compounds the image information of two or more colored light based on two or more display

devices through a color composition means, and carries out expansion projection on a screen side with a projector lens, and, as for this projector lens, is characterized by to have the means which bends the 1st lens group which has forward refractive power in order, a diaphragm, and an optical path, and the 2nd lens group which has negative refractive power from this display device side.

[0016] It is characterized by said projector lens carrying out incidence of the invention of claim 2 to said color composition means in invention of claim 1, without receiving the optical operation to which it is an abbreviation tele cent rucksack, and the flux of light from this display device has refractive power in said display device side.

[0017] It is characterized by a means by which invention of claim 3 bends said optical path in claim 1 or invention of 2 being prism.

[0018] It is characterized by a means by which invention of claim 4 bends said optical path in claim 1 or invention of 2 being a mirror.

[0019] In claims 1, 2, and 3 or invention of 4, invention of claim 5 is characterized by satisfying $2.0<|f2/f|<4.0$, when the focal distance of f2 and the whole system is set to f for the focal distance of said 2nd lens group.

[0020] In invention of any 1 term of claims 1–5, invention of claim 6 is characterized by satisfying $0.50<lref/ltt<0.75$, when distance to the lens plane peak point location by the side of a screen is most set to ltt for the distance to the reflector of the means which bends said optical path from said display device from lref and a liquid crystal display component.

[0021] It is characterized by invention of claim 7 satisfying $0.75<o1/f1<1.0$, when said drawing has been arranged near the optical–path bending means and the focal distance of o1 and this 1st lens group is set to f1 for the distance from this diaphragm to the principal plane location by the side of the screen about said 1st lens group in invention of any 1 term of claims 1–6.

[0022] Invention of claim 8 is characterized by the negative lens and both the lens side of the shape of a meniscus of at least two sheets to which said 2nd lens group turned the convex in order [side / said / screen] having the convex positive lens in invention of any 1 term of claims 1–7.

[0023] Invention of claim 9 is characterized by including at least one aspheric lens in said 2nd lens group in invention of any 1 term of claims 1–8.

[0024] It is characterized by the aspheric lens with which invention of claim 10 is included in said 2nd lens group in invention of claim 9 being a product made from plastics.

[0025] Invention of claim 11 is characterized by including at least one aspheric lens in said 1st lens group in invention of any 1 term of claims 1–10.

[0026] It is characterized by the aspheric lens with which invention of claim 12 is included in said 1st lens group in invention of claim 11 being a product made from plastics.

[0027] Invention of claim 13 is characterized by said 1st lens group containing at least 2 sets of lamination lenses of a positive lens and a negative lens with which a positive lens is arranged at said display device side in invention of any 1 term of claims 1–12.

[0028] It is characterized by invention of claim 14 making a focal distance adjustable in invention of any 1 term of claims 1–13 by making adjustable lens group spacing in said 1st lens group.

[0029] It is characterized by invention of claim 15 carrying out Floating adjustment by making adjustable lens spacing in said 2nd lens group in invention of any 1 term of claims 1–14.

[0030] In the projector lens with which the projector lens of invention of claim 16 projects a projection image on a predetermined side This projection image side of this projector lens is a tele cent rucksack. The 1st lens group of refractive power more nearly forward than this projection image side to order, It has drawing, the means which bends an optical path, and the 2nd lens group of negative refractive power. When distance from f and this diaphragm to the principal plane location by the side of this predetermined side of the 1st lens group is set [the focal distance of the i–th lens group] to o1 for the focal distance of fi and the whole system, it is characterized by satisfying $2.0<f2/f<4.00.75<o1/f1<1.0$.

[0031]

[Embodiment of the Invention] Drawing 1 is the important section schematic diagram of the operation gestalt 1 of the projection device which used the projector lens (projection lens) of this invention. In drawing 1 , PL is a projector lens. The projection equipment of drawing 1 consists of the liquid crystal display component (liquid crystal display) LCD side in order with the configuration of the color composition prism XPR, the 1st lens group of forward refractive power, L1, Diaphragm ST, the optical-path bending prism PR, and the 2nd lens group L2 of negative refractive power. S is a screen. ASP is the aspheric surface established in the lens side.

[0032] It exists in order [three] to display red, green, and three images for blue, but by drawing 1 , since [one] it is easy, the liquid crystal display (LCD) is shown.

[0033] The flux of light from the image of three liquid crystal displays was compounded to one by the color composition prism XPR, and it has projected on the Sth page of a screen through the 1st lens group L1, Prism PR, and the 2nd lens group L2.

[0034] The color composition prism XPR consists of the well-known cross die clo prism which stuck the triangle pole prism of a right angle 4 pieces.

[0035] With this operation gestalt, the location of drawing ST of projector lens PL seen from this color composition prism XPR is set as the method of abbreviation infinite distance, namely, the location of a liquid crystal display component side pupil consists of a tele cent rucksack of infinite distance. And the include angle of the chief ray outside a shaft in the inside of Prism XPR is less than **1 degree, and has prevented generating of the irregular color in the direction of a color composition cross section on the screen S in the color composition prism XPR (this operation gestalt screen longitudinal direction) by this.

[0036] With the projection device of this operation gestalt, the liquid crystal display component LCD is illuminated by the flux of light from an illumination system (un-illustrating). And the die clo film of color composition prism (XPR) is made to penetrate in projector lens PL, so that the chief ray outside a shaft may become parallel to the lens optical axis La, without [that is,] giving refractive power to light from the illumination system side which illuminates the liquid crystal display component LCD.

[0037] As the light transmission property by fluctuation of whenever [incident angle / of various axial outdoor daylight to said die clo film] is not influenced, he is trying to maintain a symmetrical optical property about a color composition cross section by this.

[0038] Projector lens PL after penetrating the color composition prism XPR furthermore has adopted the lens system used as the so-called retro focus type, when it sees from the screen S side containing the 1st lens group L1 which has forward refractive power, and the 2nd lens group L2 which has the means PR which bends an optical path, and negative refractive power. This has secured sufficient back focus required for arrangement of the color composition prism XPR.

[0039] About refractive-power arrangement within the 1st lens group L1, by bringing near forward refractive power by the liquid crystal display LCD side, and moving a principal plane to a liquid crystal display LCD side, it was made the focal distance ratio and the long back focus of about 3 times is secured among projector lens PL.

[0040] Moreover, the optical path is launched to about 66-degree upper part about the shorter side cross section of a liquid crystal display LCD with the prism PR arranged among the 1st and 2nd lens groups L1 and L2, and after injecting this projection device, image formation of the image of a liquid crystal display LCD is carried out to Screen S via the clinch mirror (un-illustrating) prepared into the system.

[0041] This is attaining space-saving-ization of the depth direction of equipment especially. In addition, the reflective mirror of high bandwidth is processed in the reflector of Prism PR, and the multilayer coat is processed in close and the outgoing radiation side of light.

[0042] Moreover, it is desirable to perform mask processing in order to cut a ghost and a flare into the field besides the effective diameter of the incident light study system of the reflector of Prism PR.

[0043] Small refractive-power arrangement is realized by concentrating negative refractive power on Screen S side, and moving a principal plane to Screen S side from a front ball about the 2nd lens group

L2. while this mainly amends aberration outside a shaft, such as barrel-distortion music aberration peculiar to a retro focus lens, and the chromatic aberration of magnification, good and it is a super-wide angle called the half-field angle of 46 degrees -- a circumference illuminance ratio -- it is contributing to keeping the path of a front ball small, realizing bright optical system of 70%.

[0044] moreover, the inside of the 2nd lens group L2 which has the big refractive power for earning a back focus -- two meniscus-like negative lenses have been most arranged to Screen S side, and the aspheric surface is adopted as these negative lenses. This is suppressing generating of the distortion aberration of the spool mold by the side of Screen S especially.

[0045] Moreover, when using as a projection lens, it is desirable to give a whole surface multilayer coat to a lens side for a raise in the brightness of the light source.

[0046] In addition, an aberration Fig. when the rear pro JIEKUYON lens (projector lens) of this operation gestalt is expressed per mm and carries out a focus for the numeric value of a numerical example to 0.5m (projector distance is 0.5m) is shown in drawing 4 .

[0047] Although the above configuration has attained the projection device made into the purpose of this invention, it is good to satisfy at least one of the following terms and conditions still more preferably.

[0048] (**-1) When the focal distance of f2 and the whole system is set to f for the focal distance of said 2nd lens group, it is $2.0<|f2/f|<4.0$. ..... (1)

It is satisfied.

[0049] If the upper limit of conditional expression (1) is exceeded, since the refractive power of the 2nd lens group of negative refractive power will become small and the arrangement tooth space about color composition prism decreases, evils, like the diameter of a lens by the side of a screen becomes large occur.

[0050] Conversely, since amendment of distortion, the chromatic aberration of magnification, etc. not only becomes difficult, but the negative refractive power of the 2nd lens group will become strong and a back focus will become long too much if the lower limit of conditional expression (1) is exceeded, futility generates and is not desirable to a tooth space.

[0051] (**-2) It is $0.50<lref/ltt<0.75$ when distance to the lens plane peak point location by the side of a screen is most set to ltt for the distance to the reflector of the means which bends said optical path from said liquid crystal display component from lref and a liquid crystal display component. ..... (2)

It is satisfied.

[0052] If the upper limit of conditional expression (2) is exceeded conversely, since the path of the lens by the side of a screen will become large if the lower limit of conditional expression (2) is exceeded, the refractive power of the positive lens group by the side of a liquid crystal display component becomes small, the refractive power of the positive lens group near [which bends the 2nd lens group and said optical path] the means will become large and amendment of the pin-cushion distortion by the side of a screen etc. will become difficult, it is not desirable.

[0053] (**-3) With this operation gestalt, not only prism but a mirror may be adopted as an optical-path bending means. Only in the part from which a medium becomes air as compared with the time of prism, an optical path will become short if it is made a mirror.

[0054] Then, in order to respond to the needs to bend an optical path at 90 degrees or more (specifically 114 degrees) without KERARE etc. to the shorter side cross section of a liquid crystal display component, the refractive-power arrangement optimal for the tooth-space reservation between the further 1st and 2nd lens groups must be broken down not a little.

[0055] Therefore, by this invention, as shown in drawing 7 paying attention to the point that a comparatively big tooth space can be taken in the direction of breadth of a set (screen longitudinal direction) for a rear projection set, the optical path is developed by Steering-Mirror (MR) in the direction of a shorter side cross section (the depth arrow-head ** direction of a set) concerning a liquid crystal display component in the light from [of a set] breadth (the arrow-head ** direction) (examples 2 and 3). Even if about 90 degrees of the angle of bend of Steering-Mirror are enough and it does not break down

refractive-power arrangement for tooth-space reservation required for optical-path bending, it can be managed with this system. As compared with the example which was furthermore bending the optical path by prism, the optical loss by the absorption inside the quality of the material can be prevented.
[0056] (**-4) Drawing is good to arrange near the optical-path bending means. When according to this magnitude of the prism which is an optical-path bending means, or a mirror can be made small and it especially constitutes from prism etc., it is possible to also hold down about [suppressing the optical loss by internal absorption to min], weight, and cost.
[0057] (**-5) Said drawing is $0.75<o1/f1<1.0$, when it has been arranged near the optical-path bending means and the focal distance of o1 and this 1st lens group is set to f1 for the distance from this diaphragm to the principal plane location by the side of the screen about said 1st lens group. ..... (3) It is satisfied.
[0058] This is description about the tele cent rucksack engine performance about a liquid crystal display component side, i.e., a color composition prism side. It is not desirable that amendment of the aberration outside a shaft not only becomes difficult, but the refractive power of the 1st lens group will become large too much, matching with an illumination system will worsen if the lower limit of conditional expression (3) is exceeded, and the illuminance ratio in the circumference of a screen is downed especially etc.
[0059] Conversely, also by exceeding a upper limit, although it is advantageous to amendment of the aberration outside a shaft, the illuminance in the circumference of a screen is downed like point **.
[0060] (**-6) Said 2nd lens group is that the negative lens-like negative lens of the shape of a meniscus of at least two sheets with which the convex was turned in order [side / said / screen], and both the lens side have the convex positive lens.
[0061] When [of a super-wide angle lens] a back focus is long, this is a thing for making a beam of light crooked gently and leading to a screen by the 2nd lens group, in order to carry out skillful ****** of the aberration outside a shaft.
[0062] Moreover, by constituting the 2nd lens group in this way, a principal plane location is moved to a screen side, and the configuration of a system is used as the compact.
[0063] (**-7) It is that at least one aspheric lens is included in said 2nd lens group.
[0064] It makes it easy to amend the pin-cushion distortion aberration by the side of a screen by this.
[0065] (**-8) The aspheric lens contained in said 2nd lens group is a product made from plastics.
[0066] It is desirable to set the quality of the material of the aspheric lens when adopting an aspheric lens as the 2nd lens group to pmma which is comparatively excellent in a polarization property, i.e., an optical distortion property, for example.
[0067] (**-9) It is that at least one aspheric lens is included in said 1st lens group.
[0068] In order that the positive lens by the side of the liquid crystal display component of the 1st lens group may also carry out the same operation as the negative lens of the 2nd lens group, it is good to adopt an aspheric lens as this. According to this, it becomes easy to amend the pin-cushion distortion aberration by the side of a screen good.
[0069] (**-10) The aspheric lens contained in said 1st lens group is a product made from plastics.
[0070] Acrylic pmma which is comparatively excellent in a polarization property, i.e., an optical distortion property, about especially this quality of the material is desirable.
[0071] (**-11) Said 1st lens group is that the lamination lens of a positive lens and a negative lens with which a positive lens is arranged at said liquid crystal display component side is included at least 2 sets.
[0072] It becomes effective in amending the chromatic aberration of magnification by this moving the principal plane location of the 1st lens group to a liquid crystal display component, and securing a long back focus, and sticking.
[0073] (**-12) By making adjustable lens group spacing in said 1st lens group, it is making a focal distance adjustable.
[0074] When it thinks from the needs of rear projection equipment like this invention, it is good to

establish the scale-factor adjustment device for absorbing the manufacture error variation of many lenses. At this time, it is desirable by making adjustable lens group spacing in the 1st lens group to make a focal distance adjustable on aberration amendment.

[0075] (**-13) It is carrying out Floating adjustment by making adjustable lens spacing in said 2nd lens group.

[0076] Although a focal device is required also because of the smooth conversion to various screen sizes, in order to amend the failure by the image surface where the wide angle lens in that case is characteristic, it is good to carry out Floating adjustment by making adjustable lens spacing in the 2nd lens group.

[0077] Drawing 2 is the important section schematic diagram of the operation gestalt 2 of the projection equipment which used the projection lens of this invention.

[0078] The projection equipment of drawing 2 consists of the liquid crystal display LCD side in order with the configuration of the color composition prism XPR, the 1st lens group L1 of forward refractive power, the optical-path bending mirror MR, and the 2nd lens group L2 of negative refractive power. Mirror MR is carrying out the operation of reflection and a diaphragm.

[0079] Unlike the operation gestalt 1, with this operation gestalt, one aspheric lens (aspheric surface ASP) is arranged in the 1st lens group L1 and each 2nd lens group L2.

[0080] Moreover, it differed in the operation gestalt 1 as an optical-path bending means, and Mirror (Steering-Mirror) MR is adopted.

[0081] With this operation gestalt, as shown in drawing 7 paying attention to the point that a comparatively big tooth space can be taken, in the direction (the direction of 90 degrees) of a shorter side cross section (arrow-head **) concerning a liquid crystal display LCD in the light from set breadth (arrow-head **), the optical path was bent in the direction of breadth of a rear projection set, and it is developing in Steering-Mirror MR in it. It not only becomes possible to suppress breaking down refractive-power arrangement for tooth-space reservation required for optical-path bending, but thereby, about 90 degrees is enough as the angle of bend of Steering-Mirror MR, and it can prevent loss by the absorption inside the quality of the material as compared with the example which was bending the optical path by prism.

[0082] Since others are the same as that of the operation gestalt 1, detailed explanation is omitted.

[0083] In addition, the aberration Fig. when carrying out the focus of the rear projection lens (projection lens) of this operation gestalt to 0.5m is shown in drawing 5 .

[0084] Drawing 3 is the important section schematic diagram of the operation gestalt 3 of the projection equipment which used the projector lens of this invention. The projection equipment of drawing 3 consists of the liquid crystal display LCD side in order with the configuration of the color composition prism XPR, the 1st lens group L1 of forward refractive power, the optical-path bending mirror MR, and the 2nd lens group L2 of negative refractive power.

[0085] Unlike the operation gestalt 2, with this operation gestalt, two aspheric lens [one] (aspheric surface ASP) is arranged in each 2nd lens group L2.

[0086] Moreover, as an optical-path bending means, it differed in the operation gestalt 1 and Mirror (Steering-Mirror) MR is adopted.

[0087] With this operation gestalt, as shown in drawing 7 paying attention to the point that a comparatively big tooth space can be taken, in the direction (the direction of 90 degrees) of the direction of a shorter side (arrow-head **) concerning a liquid crystal display LCD in the light from set breadth (arrow-head **), the optical path was bent in the direction of breadth of a rear projection set, and it is developing in Steering-Mirror MR in it.

[0088] Thereby, it not only becomes possible to suppress breaking down refractive-power arrangement for tooth-space reservation required for optical-path bending, but about 90 degrees of the angle of bend of Steering-Mirror MR are enough, and it can prevent loss by the absorption inside the quality of the material as compared with the example which was bending the optical path by prism.

[0089] Since others are the same as that of the operation gestalt 2, detailed explanation is omitted.
[0090] In addition, the aberration Fig. when carrying out the focus of the rear projection lens (projection lens) of this operation gestalt to 0.5m is shown in drawing 6 .
[0091] Next, the numerical example of this invention is shown. In addition, in a numerical example, from a screen side, in order, Ri is the i-th radius of curvature, and Di is a refractive index and the Abbe number, respectively. [as opposed to / from a screen side / in the thickness of the i-th optical member or air spacing, nickel, and nui / side / screen / order / d line of the ingredient of the i-th optical member to order]
[0092] Moreover, the last two fields in a numerical example show a light filter, a face plate, etc.
[0093] An aspheric surface configuration is [0094], when the travelling direction of H shaft and light was made forward to the X-axis, the optical axis, and the perpendicular direction in the direction of an optical axis, R is made into paraxial radius of curvature and it makes A, B, C, D, and E an aspheric surface multiplier respectively.
[Equation 1]

$$X=\frac{(1/R)H^2}{1+\sqrt{(1-(1+K)(H/R)^2)}}+AH^2+BH^4+CH^6+DH^8+EH^{10}$$

[0095] It expresses with the becoming formula.
[0096] Moreover, the relation between the above-mentioned monograph affair type and a numerical example is shown in Table -1.
The numerical example 1 fno.1:2.4 2omega=46 degreex2 R 1= 56.735 D 1= 4.20 N 1=1.49376 nu 1= 57.1 *R 2= 34.761 D 2= 11.03 R 3= 48.612 D 3= 3.60 N 2=1.49376 nu 2= 57.1 *R 4= 33.416 D 4= 20.16 R 5= 101.142 D 5=3.50 N 3=1.65355 nu3= 52.0 R 6= 26.619 D 6= 9.71R 7= 1201.789 D 7= 3.10 N 4=1.66041 nu 4= 51.0 R 8=45.000 D 8= 5.86 R 9= 96.151 D 9= 5.69 N 5=1.83932 nu 5= 37.2 R10=-143.905 D10= 3.65 R11= infinity D 11= 42.50 N 6=1.51825 nu 6= 64.1 R12= infinity (diaphragm) D 12= 12.18 R13=-250.900 D 13= 2.50 N 7=1.83932 nu 7= 37.2 R14= 25.357 D 14= 10.23 N 8=1.81264 nu 8= 25.4R15=-108.581 D15= 0.10 R16= 43.723 D16= 9.32 N 9=1.48915 nu 9= 70.2 R17= -49.690 D17= 4.10 R18= -49.244 D18= 2.60 N 10= 1.80619 nu10= 27.7 R19= 45.000 D19= 8.77 N 11= 1.48915 nu11= 70.2 R20= -58.143 D20= 0.20 R21=-3521.585 D21= 3.00 N 12= 1.83932 nu12= 37.2 R22= 50.000 D22= 8.75 N 13= 1.48915 nu13= 70.2R23= -72.544 D23= 0.20 R24= 95.678 D24= 6.08 N 14= 1.48915 nu14= 70.2 R25=-163.332 D 25= 0.20 R26= 60.462 D26= 6.62 N 15= 1.48915 nu15= 70.2 R27= 1000.000 D 27= 14.50 R28=infinity D 28= 50.00 N 16= 1.51825 nu16= 64.1 R29= 2nd page of infinity aspheric surface multiplier R 3.47608D+01 K-4.21977D-1 B 1.80509D-06 C-3.31417D-09 D 1.74821D-12 E-7.16448D-164 page R 3.34163D+01 K-1.73657D-1 B-3.70371D-06 C 7.63396D-09 D-8.18170D-12 E 3.68298D-15 numeric-value example 2 fno.1:2.4 2omega=46 degreex2 R 1= 56.126 D 1= 4.20 N 1=1.49376 nu 1= 57.1 *R 2= 32.986 D 2= 12.02 R 3= 51.810 D 3= 4.00 N 2=1.66107 nu 2= 51.0 R 4= 36.042 D 4= 11.41R 5= 62.817 D 5= 3.50 N 3=1.66107 nu 3= 51.0 R 6= 29.444 D 6= 12.84 R 7=-116.031 D 7= 3.10 N 4=1.66108 nu 4= 50.9 R 8= 51.667 D 8= 13.86 R 9= 141.097 D 9= 8.01 N 5=1.83932 nu 5= 37.2 R10=-100.161 D 10= 37.22 R11= infinity (diaphragm) D 11= 17.03 R12= 93.714 D12= 2.50 N 6=1.83932 nu 6= 37.2 R13= 25.279 D13= 7.94 N 7=1.81264 nu 7= 25.4 R14= 159.642 D14= 0.10 R15= 37.960 D15= 8.23 N 8=1.48915 nu 8= 70.2 R16= -59.594 D16= 4.10 R17=-50.000 D17= 2.60 N 9= 1.80771 nu 9= 28.9 R18= 45.000 D18= 9.71 N 10= 1.48915 nu10= 70.2 R19= -51.417 D19= 0.20 R20=-277.052 D20= 3.00 N 11= 1.83932 nu11= 37.2 R21= 50.000 D21= 8.15 N 12= 1.48915 nu12= 70.2 R22=-85.013 D22= 0.20 R23= 54.945 D23= 9.77 N 13= 1.48915 nu13= 70.2 R24=-269.477 D24= 0.20 *R25= 72.603 D25= 6.22 N 14= 1.49376 nu14= 57.1 R26= 2757.961 D 26= 10.00 R27=infinity D 27= 45.00 N 15= 1.51825 nu15= 64.1 R28= 2nd page of infinity aspheric surface multiplier R 3.29861D+01 K-4.58369D-1 B 2.05598D-07 C-2.24051D-09 D 1.28789D-12 E-6.88048D-1625 page R7.26028D+01 K-2.82554D+00 B-1.26556D-06 C-1.21731D-09 D 3.56772D-13 E-1.11789D-15 numeric-value example 3 fno.1:2.4 2omega=46 degreex2 R 1= 56.408 D 1= 4.20 N 1=1.49376 nu 1= 57.1 *R 2= 34.719 D 2= 11.34 R 3= 49.150 D 3= 3.60 N 2=1.49376 nu 2= 57.1 *R 4=

33.405 D 4=18.33R 5= 117.783 D 5= 3.50 N 3=1.61951 nu 3= 50.7 R 6= 28.152 D 6= 10.30 R 7= 1651.255 D 7= 3.10 N 4=1.66108 nu 4= 50.9 R 8= 45.000 D 8= 11.81 R 9= 94.883D 9= 7.68 N 5=1.83932 nu 5= 37.2 R10=-140.017 D 10= 32.34 R11= infinity (diaphragm) D 11= 14.65 R12=-569.806 D 12= 2.50 N 6=1.83932 nu 6= 37.2 R13= 27.104 D13= 8.19 N 7=1.81264 nu 7= 25.4 R14=-154.044 D14= 0.10 R15= 42.097 D15= 9.22 N 8=1.48915 nu 8= 70.2 R16= -54.789 D16= 4.10 R17= -50.013 D 17= 2.60 N 9=1.81951 nu 9= 27.8 R18= 45.000 D18= 8.76 N 10= 1.48915 nu10= 70.2 R19= -56.842 D19= 0.20 R20=-1194.588 D20= 3.00 N 11= 1.83932 nu11= 37.2 R21= 50.000 D21= 8.87 N 12= 1.48915 nu12= 70.2R22= -66.895 D22= 0.20 R23= 101.029 D23= 5.60 N 13= 1.48915 nu13= 70.2 R24=-208.991 D24= 0.20 R25= 57.185 D25= 7.83 N 14= 1.48915 nu14= 70.2 R26= 1000.000 D 26= 10.00 R27=infinity D 27= 50.00 N 15= 1.51825 nu15= 64.1 R28= 2nd page of infinity aspheric surface multiplier R 3.47188D+01K-4.31944D-1 B1.79158D-06 C-3.28606D-09 D 1.75818D-12 E-7.10970D-164 page R 3.34045D+01 K-1 67858D-01 B-3.68582D-06 C 7.73398D-09 D-8.41642D-12 E 3.72052D-15[0097]

[Table 1]

条件式	実施例1	実施例2	実施例3
f2/f	2.28	3.1	3.07
lref/ltt	0.64	0.58	0.56
o1/f1	0.9	0.89	0.9

[0098]

[Effect of the Invention] The projection device using the projector lens and it which can project this image, maintaining good optical-character ability on a screen can be attained, attaining the miniaturization of the whole equipment by setting up the configuration of this projector lens appropriately, in case according to this invention the image of two or more colored light based on two or more display devices is compounded with a color composition means and it projects on a screen side with a projector lens.

[0099] In addition, the rear projection lens of a super-wide angle of 3 plate methods which can shorten the dimension of the depth direction of a set sharply especially can be attained, realizing low distortion, the outstanding color property, and a circumference illuminance ratio according to this invention.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The important section schematic diagram of the operation gestalt 1 of the projection device of this invention

[Drawing 2] The important section schematic diagram of the operation gestalt 2 of the projection device of this invention

[Drawing 3] The important section schematic diagram of the operation gestalt 3 of the projection device of this invention

[Drawing 4] Drawing of the spherical aberration at the time of the projector distance of 0.5m when

expressing the numeric value of the numerical example 1 of the projector lens of this invention per mm, a curvature of field, distortion aberration, and the chromatic aberration of magnification

[Drawing 5] Drawing of the spherical aberration at the time of the projector distance of 0.5m when expressing the numeric value of the numerical example 2 of the projector lens of this invention per mm, a curvature of field, distortion aberration, and the chromatic aberration of magnification

[Drawing 6] Drawing of the spherical aberration at the time of the projector distance of 0.5m when expressing the numeric value of the numerical example 3 of the projector lens of this invention per mm, a curvature of field, distortion aberration, and the chromatic aberration of magnification

[Drawing 7] The important section schematic diagram of the projection device concerning this invention

[Description of Notations]

PL Projection lens
L1 The 1st lens group
L2 The 2nd lens group
XPR Color composition prism
ASP Aspheric surface
S Screen
LCD Liquid crystal display (image surface)
MR Steering-Mirror
ST Diaphragm
deltaS The sagittal image surface falls.
deltaM A meridional image surface falls.

[Translation done.]